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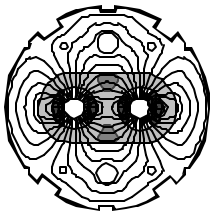

the
Large
Hadron
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project

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Interface Specification

INNER TRIPLET FEEDBOXES: DFBX – TUNNEL AND ALIGNMENT INTERFACE

Abstract

This specification establishes the detailed interface requirements for the transportation, installation and alignment of the DFBX feedboxes including mounting to the tunnel floor, lifting points and Taylor-Hobson fiducials.

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History of Changes

Rev. No.	***Date***	***Pages***	***Description of Changes***
1.0	2001-10-17		Initial submission.

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1. INTRODUCTION

All DFBX boxes in the LHC ring will have to be transported to their operating locations in the tunnel, installed, aligned, and secured to the tunnel floor. Each DFBX may be lifted from above by overhead crane or from below by forklift. (See Section 5.) Taylor-Hobson fiducials and targeting will be used to align each of the boxes once in position on the tunnel floor. Alignment is required to be ?0.5 mm in X and Z, and ?1 mm in Y. Range of adjustment for the DFBX on the IRS jacks is ?10 mm in all three directions.

2. DFBX EQUIPMENT CODES

Because each of the eight DFBX has a unique design, the following equipment codes have been adopted facilitating a direct application of the LHC documentation system. In the table, "IRnR" signifies the right side of the Interaction Point n, and "IRnL" signifies the left side of Interaction Point n.

Location	IR1 L	IR1 R	IR2 L	IR2 R	IR5 L	IR5 R	IR8 L	IR8 R
Code	DFBXA	DFBXB	DFBXC	DFBXD	DFBXE	DFBXF	DFBXG	DFBXH

3. CO-ORDINATE SYSTEM

The local coordinate systems used in this specification with respect to the DFBX are given in the DFBX General Interfaces Specification [1] and shown in the figures below. The local coordinate system is defined by the following:

- X=0, Z=0 at center of beam line.
- Y=0 at front face of flange.
- Positive X is toward the machine center.
- Positive Y is in clockwise beam direction.
- Positive Z is vertical up from LHC plane.

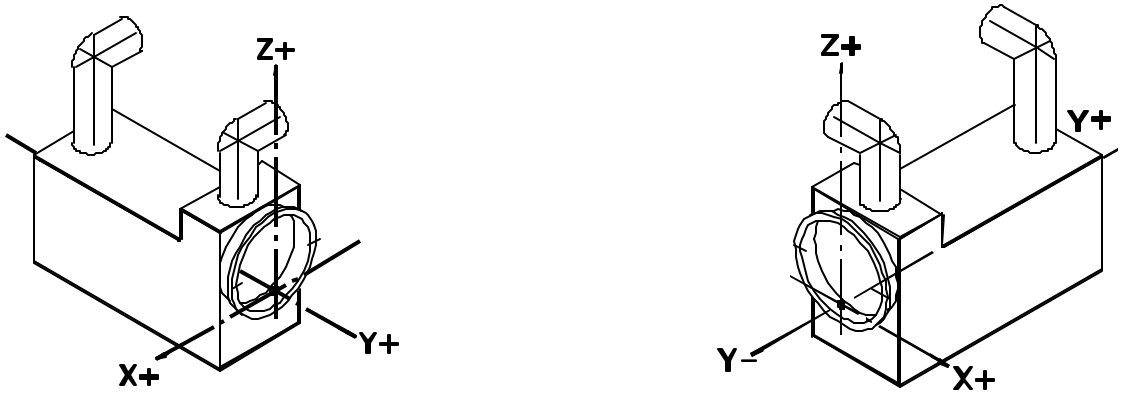

Figure 3-1. DFBX co-ordinate system – left and right sides of IP.

The origins of the DFBX local coordinate systems with respect to the CERN global coordinates are listed in Table 3-1. In deriving these locations we use the referenced CERN drawing and set the flange to flange separation between the DFBX and the LQX to be 510 mm [2].

Table 3-1. Position of DFBX Local Coordinate Systems

Code	Distance (mm) from IP	CERN Dwg. No.	Dwg. Ref. List
DFBXA	55052 Left of IP1	LHCLSX__0001E	[a]
DFBXB	55052 Right of IP1	LHCLSX__0002E	[b]
DFBXC	55052 Left of IP2	LHCLSX__0003E	[c]
DFBXD	55052 Right of IP2	LHCLSX__0004E	[d]
DFBXE	55052 Left of IP5	LHCLSX__0009E	[e]
DFBXF	55052 Right of IP5	LHCLSX__0010E	[f]
DFBXG	55052 Left of IP8	LHCLSX__0015E	[g]
DFBXH	55052 Right of IP8	LHCLSX__0016E	[h]

4. SHIPPING CONFIGURATION

The DFBX is supported in a shipping crate on soft-mounts designed to minimize shock and vibration transmitted to the DFBX assembly during transport. Each crate contains two DFBX assemblies and the associated mounting components and hardware. The I.S.R. jacks used for mounting the DFBX to the tunnel floor and the bumper brackets used to restrain the DFBX under thrust loads will be labelled and packed in a box shipped with the DFBX. A spreader bar which attaches to four hoist rings at the upper corners of the DFBX will be packaged with the first DFBX and retained for lifting each DFBX assembly. Table 4-1 lists components associated with the DFBX installation. After the hardware fastening the shipping mounts to the crate and the DFBX are removed, the DFBX may be lifted off the mounts using an overhead crane and the DFBX spreader bar.

Table 4-1 DFBX and components for installation of each DFBX assembly.

Component	Quantity	Responsibility
DFBX Assembly	1	LBNL
I.S.R. jack	3	LBNL
Floor anchor (Hilti-type)	24	CERN
Spreader bar lifting fixture[1]	1	LBNL
Rollers for DFBX[1,2]	2	CERN
Collapsible transfer table[1]	1	CERN
Tie rod bracket and hardware set	4	LBNL
Taylor-Hobson fiducial ball assembly	3	CERN
Fiducial bracket and hardware set	3	LBNL
Bumper bracket and hardware set	3	LBNL

1. One unit provided for use with all 8 DFBX.
2. Required if DFBX transported through tunnel TI2.

5. LIFTING

Figure 5-1 shows the locations of the hoist rings on the DFBX box. The approximate mass of the assembled DFBX is 6 Tonnes. A special lifting fixture, including spreader bar and cables, is provided with the first DFBX to protect the current leads and equipment on the top of the box during lifting. The same lifting fixture can be used for all eight DFBX. Figure 5-2 is a sketch of the lifting fixture. The distance from the bottom of the DFBX to the crane hook is 3.35 meters. The DFBX box should only be lifted using this fixture and the DFBX hoist rings. Since the assembled DFBX box contains precisely-positioned pipes of various diameters supported in place by G-10 spiders, it is important that the box is lifted and lowered in a smooth and gradual motion to minimize shock loads to the internal equipment. Acceptable levels of shipping and transfer loads are listed in Table 5-1. The DFBX vacuum vessel and shipping crate will be instrumented with shock indicators. The shipping crate will be equipped with soft-mounts to reduce general transport loads to acceptable levels. The shock sensors will indicate the maximum levels seen on the vacuum vessel during transport and transfer.

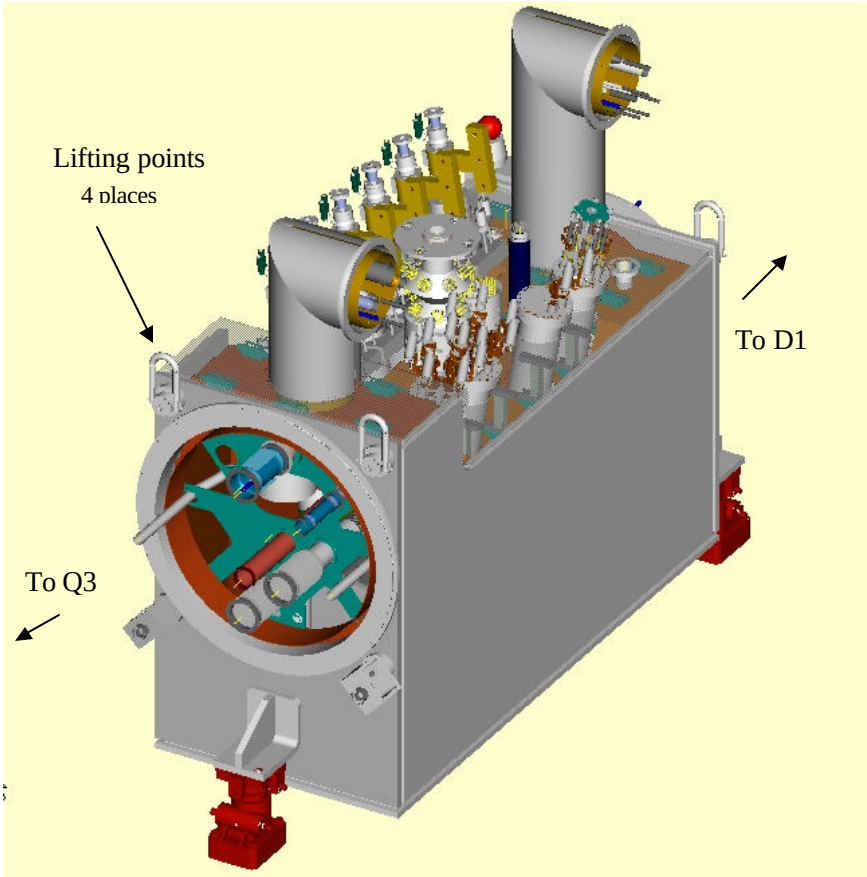

Figure 5-1 Lifting Point Locations on the DFBXC. (Locations are the same for all DFBX.)

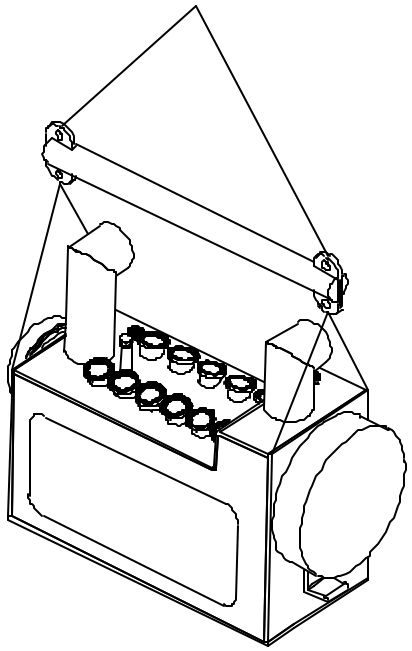

Figure 5-2 Sketch of spreader bar for DFBX.

Table 5-1 Maximum acceptable transport and transfer loads for the DFBX.

Direction of load*	DFBX in crate (g's)	DFBX alone (g's)
Lateral (±X)	**< 1**	? **1**
Vertical (±Z)	**< 2**	? **1**
Axial (±Y)	**< 4**	? **1**

***According to the coordinate system in Figure 3-1.**

6. TRANSPORTING DFBX TO OPERATING LOCATION

Once uncrated and at the LHC ring access position, the DFBX should be lifted by overhead crane onto a CERN transport cart. The box should be lowered onto the cart in accordance with the allowable loads outlined above. The cart will be used to move the box adjacent to its location in the ring.

Because of its height (2071 mm from the bottom of the box to the top of the QRL chimneys), the DFBX may require a low transport vehicle or rollers mounted directly to the DFBX, if routed through the injection region tunnel, TI2 (1.5 m radius). The footprint of the DFBX vacuum vessel is 2.2 meters by 1.0 meter. For general transport, the cart height should be no greater than 32 cm to stay within the tunnel transport space.

7. INSTALLATION OF DFBX BOX

Before installing the DFBX, the base of each of the supporting jacks must be installed in place on the tunnel floor. They are attached to the tunnel floor with 4 Hilti-type anchors, each rated for 29.4 kN (6600 lbs).

Two jacks are located near the corners of the LBX end of the box, and the third is centered on the LQX end. Figure 7-1 shows a sketch of the jack placement. The upper portion of the jacks mount to the bottom of the brackets welded on the DFBX vessel as shown in Figure 7-1. These rest on the jack bases to support the DFBX assembly. Once the jack bases are secured to the floor, the DFBX may be moved from the transporter cart onto the jacks using a special collapsible transport table. The box is supported on the spherical bearing surfaces of the three jacks simulating a kinematic support condition. The jacks are manually adjusted (?10 mm in three directions) and can be accessed at each end of the box. The jacks will be installed with alignment screws at mid-height. Protective covers on the current leads, and feedthroughs may be removed once the DFBX is installed.

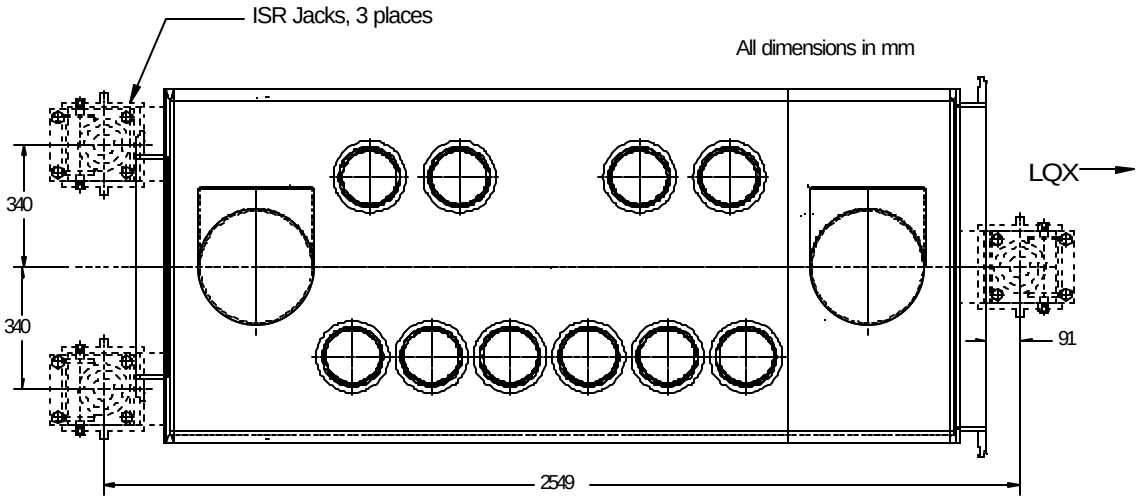

Figure 7-1 Support Jack Placement for the DFBX. (Box shown is for DFBXC,G; dimensions are identical for all other DFBX boxes.)

8. ALIGNMENT

With the box supported on the jacks, the DFBX will be aligned using the Taylor-Hobson fiducials assemblies which mount to the top of the DFBX box (See Figure 8-1). Brackets for the fiducial bases are packed with the DFBX. The brackets employ locating pins which recapture the fiducialized positions for the tooling ball bases originally determined and recorded at LBNL.

The alignment requirements for the DFBX are ? 0.5 mm in the X, and Z directions and ? 1 mm in the Y direction. See Tables 8-1 and 8-2 for nominal locations of fiducials and tolerances.

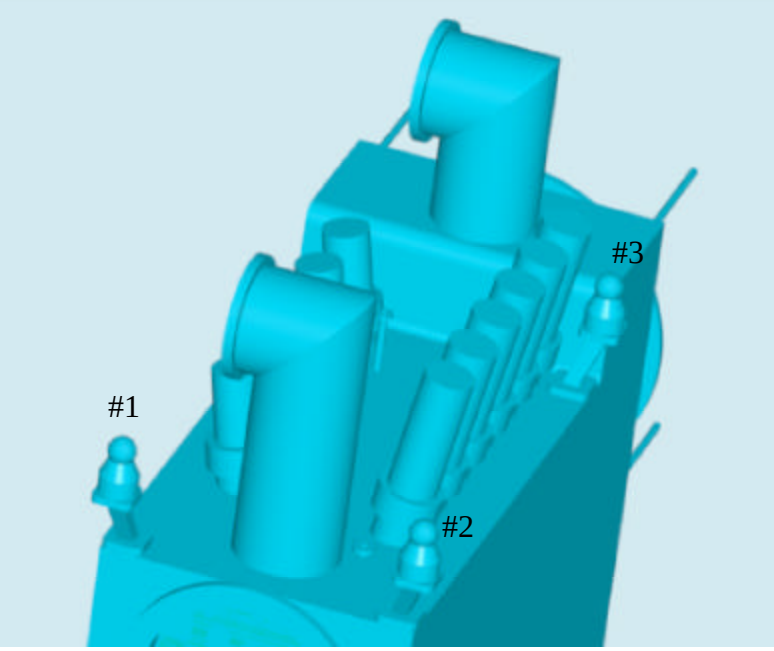

Figure 8-1. View of Taylor-Hobson Fiducials on DFBXC and G.

Table 8-1 Nominal locations of fiducials for all DFBX left of the IP.*

Fiducial	X – location ? 0.2 mm	Y – location ? .2 mm	Z – location ? 0.2 mm
#1	-430.5	-2349.3	597.0
#2	430.5	-2349.3	597.0
#3	490.5	-645.2	597.0

***** Locations are relative to the left side coordinate system shown in Figure 3-1. Exact locations of fiducials will be recorded at assembly and shipped with each DFBX.

Table 8-2 Nominal locations of fiducials for all DFBX right of the IP.*

Fiducial	X – location ? 0.2 mm	Y – location ? 0.2 mm	Z – location ? 0.2 mm
#1	-430.5	2349.3	597.0
#2	430.5	2349.3	597.0
#3	490.5	645.2	597.0

***** Locations are relative to the right side coordinate system shown in Figure 3-1. Exact locations of fiducials will be recorded at assembly and shipped with each DFBX.

9. INSTALLATION OF BUMPER AND TIE ROD BRACKETS

With the DFBX box installed and aligned, the bumper brackets may be installed in the locations shown in Figures 9-1 and 9-2. The bumper brackets are designed to keep the box in place under vacuum thrust and catastrophic pressure loads while preserving the box alignment. Each bumper is in contact with the box side and secured to the tunnel floor using four anchors. Each anchor is rated to withstand a pullout load of 29.4 kN

(6690 lbs). The bumper brackets are positioned against the ends of the DFBX, allowing the mounting holes for each bracket to be marked in place on the floor. The brackets are removed to drill and insert the anchors; then replaced and bolted down.

Four tie rods connecting the LQXB cryostat to the DFBX box are used to react vacuum thrust loads from the LQXB and possible thrust loads induced by an overpressure of the LQXB. The bumper brackets used to secure the DFBX to the tunnel floor are designed to react these loads. The D1 magnet support jacks are able to resist vacuum loads, thus no external tie bars are required on the LBX side.

The two lower tie rod brackets are shipped assembled to the DFBX; the upper tie rod brackets and mounting hardware are shipped in a box inside the DFBX crate. The upper tie rod brackets mount to the hoist ring bosses on the LQX side of the DFBX. The hoist rings must be removed to install the upper tie rod brackets. The tie rods extending from the LQX may be attached to the tie rod brackets once the DFBX has been installed, aligned and connection to the LQXB completed.

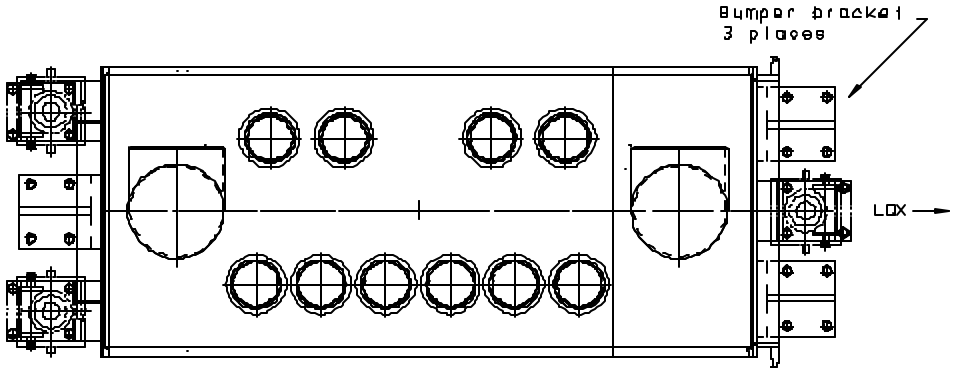

Figure 9-1. Typical bumper bracket locations shown on DFBXC and G; locations are the same for DFBXA and E.

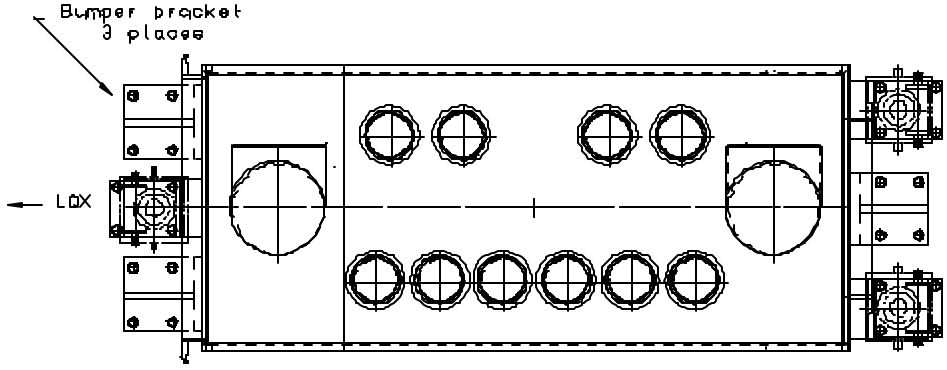

Figure 9-2. Typical bumper bracket locations shown on DFBXD and H; locations are the same for DFBXB and F.

10. INTERCONNECTS

Once the DFBX has been aligned and the bumper brackets installed, the pipe connections to the adjacent components may be made [2-7].

11. DRAWINGS

a. LHCLSX__0001E, LAYOUT OF LSS V.6.3 – IR1 LEFT, 22 March 2001.

b. LHCLSX__0002E, LAYOUT OF LSS V.6.3 - IR1 Right, 22 March 2001.

c. LHCLSX__0003E, LAYOUT OF LSS V.6.3 - IR2 Left, 22 March 2001.

d. LHCLSX__0004E, LAYOUT OF LSS V.6.3 - IR2 Right, 22 March 2001.

e. LHCLSX__0009E, LAYOUT OF LSS V.6.3 - IR5 Left, 22 March 2001.

f. LHCLSX__0010E, LAYOUT OF LSS V.6.3 - IR5 Right, 22 March 2001.

g. LHCLSX__0015E, LAYOUT OF LSS V.6.3 - IR8 Left, 22 March 2001.

h. LHCLSX__0016E, LAYOUT OF LSS V.6.3 - IR8 Right, 22 March 2001.

12. REFERENCES

1. LHC Engineering Specification, “Inner Triplet Feedboxes General Interfaces”, LHC-DFBX_-ES-200.00 ver 1.0.

2. LHC Engineering Specification, “Interface Specification: Inner Triplet Feedboxes DFBX to LQX”, LHC-DFBX_-ES-210.00.

3. LHC Engineering Specification, “Interface Specification: Inner Triplet Feedboxes DFBX to LBX”, LHC-DFBX_-ES-230.00.

4. LHC Engineering Specification, “Interface Specification: Inner Triplet Feedboxes DFBX to QRL”, LHC-DFBX_-ES-240.00.

5. LHC Engineering Specification, “Interface Specification: Inner Triplet Feedboxes DFBX – Power Converters”, LHC-DFBX_-ES-250.00.

6. LHC Engineering Specification, “Interface Specification: Inner Triplet Feedboxes Electrical Signals”, LHC-DFBX_-ES-270.00.

7. LHC Engineering Specification, “Interface Specification: DFBX to Helium Gas Recovery”, LHC-DFBX_-ES-280.00.